DOCUMENT RESUME

ED 102 529 CS 001 651

AUTHOR Allik, Judith P.; Siegel, Alexander W.
TITLE The Use of the Cumulative Rehearsal Strategy: A Developmental Study.
INSTITUTION Pittsburgh Univ., Pa. Learning Research and Development Center.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO LRDC-1975/5
PUB DATE 75
NOTE 35p.

EDRS PRICE MF-$0.76 HC-$1.95 PLUS POSTAGE
DESCRIPTORS *Cognitive Processes; *Educational Research; Elementary Education; *Learning Processes; *Memory; Recall (Psychological); *Serial Learning

ABSTRACT

This study was designed to address two issues: "At what age do children spontaneously use a cumulative rehearsal strategy?" and "What effect does the use of the strategy have on their performance?" The subjects, 28 children at each of five grade levels (nursery, kindergarten, first, third, and fifth), were tested in a serial-position recall task. Stimuli were pictures of common objects and animals whose labels were one or two syllables in length. Following testing, the children were asked to report the memory strategy they had used. The assumption was made that children who were using a cumulative rehearsal strategy would perform better on series of one-syllable items than on series of two-syllable items. As predicted, nursery, kindergarten, and first grade subjects correctly recalled as many two-syllable as one-syllable items. In contrast, third and fifth graders recalled significantly more one-syllable than two-syllable items. The results indicated that young children do not spontaneously use a cumulative rehearsal strategy until after first grade and that the use of rehearsal did not facilitate overall performance of the rehearsers relative to the nonrehearsers at any grade level. (Author/WR)

LEARNING RESEARCH AND DEVELOPMENT CENTER

1975/5

THE USE OF THE CUMULATIVE REHEARSAL STRATEGY: A DEVELOPMENTAL STUDY

JUDITH P. ALLIK AND ALEXANDER W. SIEGEL

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

University of Pittsburgh

ED102529

cs 001 651

ED102529

THE USE OF THE CUM 'LATIVE REHEARSAL STRATEGY: A DEVELOPMENTAL STUDY

Judith P. Allik and Alexander W. Siegel

Learning Research and Development Center
University of Pittsburgh

1975

The research reported herein was supported by the Learning Research and Development Center, supported in part by funds from the National Institute of Education (NIE), United States Department of Health, Education, and Welfare. The opinions expressed do not necessarily reflect the position or policy of NIE and no official endorsement should be inferred. The authors wish to thank Mr. Richard Quinnette, Principal, and the teachers of Churchill Elementary School, and the teachers of Morewood Nursery School for their cooperation. The authors also wish to thank Sandra Siegel for her assistance in testing subjects.

Abstract

This developmental study was designed to address two issues: (a) At what age do children spontaneously use a cumulative rehearsal strategy? (b) What effect does the use of the strategy have on their performance?

Twenty-eight children at each of five grade levels (nursery, kindergarten, 1, 3, and 5) were tested in a serial-position recall task. Stimuli were pictures of common objects and animals whose labels were one or two syllables in length. Following testing, the children were asked to report the memory strategy they had used.

The assumption was made that children who were using a cumulative rehearsal strategy would perform better on series of one-syllable items than on series of two-syllable items. As predicted, nursery, kindergarten, and first-grade subjects correctly recalled as many two-syllable as one-syllable items; in contrast, third and fifth graders recalled significantly more one-syllable than two-syllable items. Results indicated that (a) young children do not spontaneously use a cumulative rehearsal strategy until after first grade, and (b) the use of rehearsal did not facilitate overall performance of the rehearsers relative to the nonrehearsers at any grade level. Results are discussed in terms of their theoretical implications for the study of memory development.

THE USE OF THE CUMULATIVE REHEARSAL STRATEGY: A DEVELOPMENTAL STUDY

Judith P. Allik and Alexander W. Siegel

University of Pittsburgh

Developmental studies of short-term memory (STM) have consistently found an increase in performance with age (e.g., Belmont & Butterfield, 1969; Siegel & Allik, 1973). A question that has become of increasing interest is whether these developmental changes can be attributed solely to an increase in memory span, or whether the use of memory strategies plays a more crucial role. These strategies can be compared to the "control processes" of memory proposed by Atkinson and Shiffrin (1968) in their two-dimensional model of memory. Control processes are conceptualized as being under the subject's direct control, and their selection, construction, and use depend upon the requirements of the task. In contrast to these control processes, Atkinson and Shiffrin conceptualize other features of memory as permanent structural features, including both the physical system and unvarying, built-in processes. From this perspective, the question of interest is whether the developmental performance differences found on STM tasks can be attributed primarily to changes in the control processes of the memory system.

One of the control processes, or cognitive memorization strategies, that has been thought to have a significant influence on the acquisition of material is cumulative rehearsal. The primary objectives of the present investigation were to determine at what age children spontaneously begin to use the strategy of cumulative rehearsal and to assess the influence the use of this strategy has on their performance.

The task chosen for the study is based on a serial-position recall procedure first introduced by Atkinson, Hansen, and Bernbach (1964), and used subsequently, with minor variations, in a number of studies of the development of memory (e.g., Bernbach, 1967; Hagen & Kingsley, 1968; Hagen, Meacham, & Mesibov, 1970; McCarver & Ellis, 1972). In general, a subject is shown a series of six to eight pictures, one at a time, after which the picture is placed face down in front of him. He is then shown a duplicate of one of the face-down pictures and is asked to identify the location of its match. Thus, optimal performance on this task demands that a subject remember the order in which the pictures were presented.

It is important to note that there are several verbal responses that a subject can make to the presentation of the stimuli in this procedure. A subject may produce a verbal label for a stimulus item, either covertly or overtly, and engage in no other mnemonic activity until the next stimulus item is presented (referred to as "Naming" by Flavell, Friedrichs, & Hoyt, 1970). He may repeat the name of the most recent item over and over during the inter-item interval (repetitive Naming). He may rehearse several different contiguous items together in a cumulative pattern (cumulative rehearsal). For example, if a subject is successively shown pictures of a table, a lamp, and a chair and tries to remember them in order, he might (a) say the name of each picture as it is shown to him, either aloud or to himself ("table," "lamp," "chair"); (b) repeat the name of the item several times during the inter-item interval ("table-table-table . . .," "lamp-lamp-lamp . . . ," "chair-chair-chair . . ."); (c) rehearse the items cumulatively ("table," "table-lamp," "table-lamp-chair"). The last strategy, cumulative rehearsal, can be defined as the conscious, deliberate, additive repetition, either covertly or overtly, of the information to be learned (adapted from Reitman, 1971).

The strategy of cumulative rehearsal is especially suited for tasks that require the maintenance of temporal or spatial order (Bartlett, 1932; Corballis, 1969).

In spite of the number of studies that have addressed the question of the development of rehearsal strategies, there is little consensus of opinion about either the age at which cumulative rehearsal is spontaneously used as a mnemonic strategy or its position in a hierarchy of complexity of cognitive strategies. On the one hand, Belmont and Butterfield (1971) have claimed that the "development of short-term memory is the development of spontaneous rehearsal" (p. 238). They have stated that this strategy develops relatively late and thus might never be expected to occur in the mentally retarded. On the basis of their results, Hagen and Kingsley (1968) concluded that their five-year-old subjects were not engaging in spontaneous rehearsal. On the other hand, Rohwer (1973) characterized rehearsal as a basic, as opposed to an advanced, cognitive strategy, and McCarver and Ellis (1972) suggested that their five-year-old subjects were rehearsing.

Empirical evidence indicates that the use of rehearsal facilitates performance on memory tasks. Waugh and Norman (1965) presented evidence suggesting that material that is not rehearsed is rapidly lost. These authors conceived of rehearsal as the process by which items are transferred from short-term memory store to a long-term store. They demonstrated that a transfer to long-term store does not take place when subjects are prevented from rehearsing. Craik (1970) offered additional evidence in support of Waugh and Norman's (1965) hypothesis that rehearsal is an important factor in transferring items to secondary or long-term memory. Craik (1970) found a typical serial-position effect for the free recall of lists of 15 words immediately after they were presented. After ten lists had been presented, the subjects were asked to recall as many

iter s as they could from all of the lists. It was found that the subjects were much more apt to re-recall words that had been in the primacy positions of the lists than words that had been in the recency positions, even though words from both sections had been recalled immediately after list presentation. Craik accounts for this by assuming that the earlier words in each list had received a greater number of rehearsals than the later words and thus were recalled from secondary memory, while the words in the recency positions had originally been recalled from primary memory and were not available for later recall.

Rundus and Atkinson (1970) found that the probability of the recall of an item was an increasing function of the number of rehearsals of that item. Adult subjects were instructed to overtly rehearse visually presented nouns. Following a series, the subjects were given a written free-recall test. It was found that the items at the beginning of the lists were accorded more rehearsal time than later items and that they had a greater probability of recall than items from the middle of the lists. This strong relationship between the probability of recall and rehearsal was also found by Rundus (1971), who suggested that rehearsal provides a good indicator of the probability of retrieval.

A variety of methods have been used to study the process of rehearsal. Rundus and Atkinson (1970) and Rundus (1971) attempted to make the rehearsal process directly observable by instructing their subjects to rehearse aloud and tape-recording their overt behavior. Although one study of children has used electromyographic and sound recording equipment (Locke & Fehr, 1970b), most studies of children's rehearsal strategies have employed observational or inferential techniques. Kingsley and Hagen (1969) studied the effects of rehearsal by requiring subjects to overtly label and rehearse the items to be remembered, while Hagen and Kingsley (1968) and McCarver and Ellis (1972) inferred the presence or

absence of rehearsal from differential performance in label and no-label conditions. Flavell and his colleagues have studied memory strategies in children using a variety of techniques, including lip-reading (Flavell, Beach, & Chinsky, 1966; Keeney, Cannizzo, & Flavell, 1967; Flavell, Friedrichs, & Hoyt, 1970) and behavioral observation (Appel, Cooper, McCarrell, Sims-Knight, Yussen, & Flavell, 1972).

Unfortunately, efforts to directly study the process of rehearsal share one or more shortcomings. If the subjects are required to rehearse aloud, several problems immediately arise: (a) There is no assurance that overt rehearsal is similar to covert rehearsal; (b) there is evidence that overt verbalization may actually interfere with performance (Conrad & Hull, 1968; Hagen & Kingsley, 1968; Hagen, Meacham, & Mesibov, 1970); and (c) overt labeling introduces an auditory component into the task, and this change in the functional modality of the stimuli has been shown to cause a higher recency effect (Conrad & Hull, 1968; Crowder & Morton, 1969; Siegel & Allik, 1973). In addition, the observational techniques: (a) risk missing possibly the most efficient rehearsers of all (Locke & Fehr [1970] found that lip movements that were clearly evident on their recording equipment were not visible to an observer); (b) are applicable only to younger children; and (c) cannot be used for direct comparisons across age groups.

The method used to study cumulative rehearsal in the present study is one that eliminates several of these shortcomings. The subjects are not required to rehearse aloud, and a direct observation of their overt behavior is not necessary. Furthermore, it can be used across wide age ranges. The method is based on two important assumptions: (a) Cumulative rehearsal takes place in a verbal-auditory representational system, and (b) the length of time needed to covertly rehearse an item will depend upon the amount of time needed for its articulation.

It is evident that cumulative rehearsal of pictorial material cannot take place in an auditory-motor representational system if verbal labels are not produced for the stimuli. However, is it possible for cumulative rehearsal to take place in a visual representational system? Shaffer and Shiffrin (1972) have provided evidence that there is no direct analog of verbal rehearsal in the processing of complex visual information. Bartlett (1932) noted that subjects who were required to recall the order of sequence of a series of faces were able to do so accurately only when they noticed that there was a name assigned to each face. Those subjects who attempted to rely on visual imagery for the sequential recall made frequent errors. Bartlett hypothesized that words are superior to images in tasks that involve the maintenance of order.

Paivio (1971) has argued that the verbal system is specialized for sequential processing, as in serial memory tasks, because of its auditory-motor nature. A study by Paivio and Csapo (1969) supported this hypothesis. When pictures were presented at a rate fast enough to preclude verbal labeling (5.3 items per second), serial learning scores were significantly lower than for visual words presented at the same rate. When a slower rate of presentation was used (2 items per second), subjects were able to recall the serial order of pictures as well as they recalled the serial order of concrete words. Thus, the availability of the verbal labels was crucial to sequential memory.

Hintzman (1967) stated: "If word length were held constant, the size of the memory span should depend on the number of syllables per word: the more syllables per word the subject must rehearse, the fewer words he should be able to retain" (p. 316). There is empirical evidence to support this suggestion. Eriksen, Pollack, and Montague (1970) demonstrated that subjects implicitly name a word or number before voicing it as part of the perceptual process for visually presented stimuli. They found that it took subjects longer to voice the name of two-digit numbers

whose verbal response consisted of four syllables than it did when the response was of two syllables. It has been found that subvocal speech, which increases significantly during the silent performance of language tasks (McGuigan, 1970), is a form of speech (Locke & Fehr, 1970a) and is especially evident during recall rehearsal (Locke & Fehr, 1972). Additionally, work by Landauer (1962) suggests that implicit speech occurs at about the same rate as overt speech. Thus, the more syllables a word has, the longer it takes to say the word, whether the speaking is implicit or overt (Colgate & Eriksen, 1970). Rather than words, the stimuli in the present study are pictures of common objects or animals that have either one- or two-syllable labels.

In this study, children were shown a series of pictures one at a time, in series of seven, and were then shown a duplicate picture of one of the stimulus items and asked to turn over the match. If the seven pictures in a series have one-syllable labels, the series should take less time to rehearse than a series in which the seven pictures have two-syllable labels. By examining the relative performance on one- and two-syllable series across ages, it should be possible to determine at what point in development cumulative rehearsal begins to be utilized as a memory strategy, as well as when it becomes efficient enough to create a significant effect on performance. To avoid the interference that is created by the use of repeated stimuli (Keely, 1971), no stimulus item was used more than once for any individual child. To insure that each child had an appropriate verbal label for each item (McCarver & Ellis, 1972), children were asked to name the pictures before the task began.

Children at five grade levels were tested: nursery, kindergarten, first, third, and fifth. Three basic predictions were made: First, overall performance should increase with age. Second, nursery and possibly kindergarten children should not be using a cumulative rehearsal strategy and therefore should perform equally well on the one- and two-syllable

series. Third, older subjects (Grades 3 and 5) should use a cumulative rehearsal strategy to facilitate their performance on this task and thus should correctly recall more one-syllable than two-syllable items. Furthermore, because the difference in performance that was expected with older subjects between the two-syllable length conditions was attributed to the relative effects of condition on cumulative rehearsal, it was predicted that the differences would occur primarily at the primacy positions of the serial position curve.

Method

Subjects

Twenty-eight children at each of five grade levels (nursery, kindergarten, 1, 3, and 5) participated in the experiment. The mean age of the nursery school subjects was 4 years-7 months (range = 46-65 months), that of the kindergarteners was 5 years-9 months (range = 64-80 months), that of the first graders was 6 years-9 months (range = 77-95 months), that of the third graders was 8 years-9 months (range = 100-115 months), and that of the fifth graders was 10 years-10 months (range = 124-142 months). All subjects were average or above average in intelligence and were from middle-class socioeconomic backgrounds. At each of the five grade levels, 14 boys and 14 girls were tested.

Stimuli

Stimuli were 126 black line drawings of common, easily labeled objects and animals; each picture was drawn on a 3 x 5-inch white card. Sixty-three of the pictures had one-syllable labels and 63 had two-syllable labels. The two lists of items had been constructed from pairs of words, one of each syllable length, that had been equated for frequency using the Carroll, Davies, and Richman (1971) norms. Every effort was made to

exclude items that had more than one commonly used label. A duplicate of each item was available for use as a probe stimulus.

The pictures were shown in series of seven, and there were seven series composed of one-syllable items and seven series composed of two-syllable items. Each subject was given 14 series. No stimulus was used more than once in either syllable length condition.

Procedure

Each child was tested individually in a session lasting approximately 25 minutes. The subject was told that he was going to play a game with pictures, but that before playing the game, the experimenter would like him to look at each picture and tell her what it was. The experimenter then showed the subject one-syllable items until the subject had successfully identified 49 of them. If the subject hesitated markedly before naming a picture or did not use the appropriate syllable length label for the picture, that item was not used for the testing session for that subject. The same procedure of item labeling and selection was then used for the two-syllable items.

The 49 words of each syllable length condition that the child had appropriately labeled were then randomly assigned to seven 7-item series, and the child was given a short intervening task (such as coloring or looking at a picture book) while the experimenter located the necessary duplicate probe cards. The pretesting resulted in essentially random assignment of pictures to serial positions.

The serial positions to be probed were determined by the subject's preassigned series and probe order. Two random orders of series were used, one beginning with a one-syllable series and ending with a two-syllable series and the other beginning with a two-syllable series and ending with a one-syllable series. Within each order the restriction was

that no more than two one- or two-syllable series were presented successively. One item was probed in each series. Seven probe orders were generated, using a Latin square design, and each serial position was probed once within each syllable length condition.

During testing, the child sat at a table opposite the experimenter. Each child received at least one 4-item practice trial, using pictures that had not been selected for the testing session. Children were given the following prototypic instructions:

> Now we are going to play a game with the pictures. I'm going to show you some pictures, one at a time, and put them face down in a row in front of you. I want you to watch each picture carefully and remember where it is because I'm going to show you a picture that is just like one of the pictures you have seen, and I want you to find the one that is just like it.

If the child was correct on the first practice trial, the experimenter praised his performance, emphasizing that the subject had "found the right picture on the very first try!" If the child was not correct, he was permitted to continue until he found the correct card; he was then given additional practice trials until his first response was correct. (Very few children required more than two practice trials; none required more than three.) In this way, it was assured that even the youngest children understood what was required of them.

Following the practice series, the child was told that he would play the game the same way, but that seven pictures would be used. During testing, if the subject was not correct on his first choice, he was permitted to turn over two additional cards. After the third incorrect response, the experimenter said, "Let's see if it is right here," and turned over the correct card. The position of all the subject's responses was recorded. General social reinforcement was given to ensure sustained attention and motivation.

All series were presented from left to right. There was a four-second inter-item interval, with each picture being exposed for approximately two seconds. A silent metronome (visible only to the experimenter) was used to time stimulus presentation. After each subject was tested, the pictures that had been used during his testing session were recombined with the remaining cards of the same syllable length and the "decks" were shuffled to assure that each of the 63 cards in each syllable length condition had an equal probability of being shown to each subject.

Posttest Inquiry

After the 14 experimental series had been completed, each subject was asked how he had remembered the pictures that had been presented. If the response was not clear to the experimenter, the subject was asked to go through one more trial and "say out loud" whatever it was that he had done during the stimulus presentation.

Results

Overall Performance

The number of correct responses in each syllable length condition (7 possible) was tabulated for each subject. These scores were subjected to a 5 (Grade) x 2 (Sex) x 14 (Subjects/Cell) x 2 (Syllable Length) mixed factorial analysis of variance, with repeated measures on the last factor. The results of the analysis are summarized in Table 1.

The between-subjects portion of the analysis yielded a highly significant main effect of grade level, F (4, 130) = 21.23, $p < .001$. Scheffé (.05) confidence intervals indicated that the mean performance of the nursery school subjects (39 percent) was significantly poorer than that of subjects in the other four grades. The performance of the kindergarteners (55 percent) and first graders (54 percent) was not significantly less than that of the third graders (64 percent), but the performance of both was

significantly less than that of the fifth graders (70 percent). Third and fifth graders did not differ significantly from each other. Neither the main effect of sex nor the Grade x Sex interaction was significant, $F < 1$.

Table 1

Summary of Analysis of Variance of Number of Correct Responses in One- and Two-Syllable Length Conditions

Source of Variation	df	MS	F
Between Subjects	139		
Grade	4	37.54	21.23**
Sex	1	.01	.01
G x S	4	1.06	.60
Error (between)	130	1.77	
Within Subjects	140		
Length	1	1.73	1.48
G x L	4	3.13	2.68*
S x L	1	.36	.31
G x S x L	4	1.96	1.68
Error (within)	130	1.17	
Total	279		

*$p < .05$
**$p < .001$

The main effect of syllable length was not significant, F (1, 130) = 1.48, $p > .05$. However, as predicted, the Grade x Syllable Length interaction was significant, F (4, 130) = 2.68, $p < .05$. The percentage of correct responses for one- and two-syllable series was tabulated at each grade level and the means are presented in Table 2. Planned comparisons (Hays, 1973) indicated that the difference in performance on one- and two-syllable series was not significant for the nursery, kindergarten, or first-

grade subjects, $p > .05$. At these grade levels, subjects performed equally well in both syllable length conditions. As predicted, both third graders and fifth graders recalled significantly more one-syllable items than two-syllable items. The difference at Grade 3 was significant at the .05 level; the difference at Grade 5 was significant at the .001 level.

Table 2

Percent Correct Responses at Each Grade Level

Grade Level	N	One-Syllable Items	Two-Syllable Items
Nursery	28	37	40
Kindergarten	28	53	57
Grade 1	28	54	54
Grade 3	28	67	60
Grade 5	28	76	64

Serial Position Analyses

The percentage of correct responses at each of the seven serial positions (summed over 14 Subjects/Cell) was tabulated and subjected to an arcsin transformation.[1] These transformed scores were subjected to a 5 (Grade) x 2 (Sex) x 2 (Syllable Length) x 7 (Serial Position) mixed factorial analysis of variance with repeated measures on the last two factors; the results are presented in Table 3. The main effect of serial position was highly significant, $F(6, 24) = 31.13$, $p < .001$. The Grade x Serial Position interaction was also significant, $F(24, 24) = 2.31$, $p < .05$, and

[1] It should be noted that the score at any one serial position is binomially distributed. The response is either correct or it is incorrect. Therefore, an arcsin transformation is necessary to normalize the distribution before the analysis of variance is performed. The formula used was $y = \arcsin \sqrt{x}$.

is portrayed graphically in Figures 1 and 2. The shape of the curves at all grade levels suggests primacy and recency. Planned comparisons (Hays, 1973) (.05) indicated significant primacy effects (performance at Position 1 > performance at Position 3) at all grade levels except Grade 5 and significant recency effects (performance at Position 5 < performance at Position 7) at all grade levels. (The lack of a significant primacy effect at Grade 5 is due to superior performance at the four initial positions.)

Table 3

Summary of Analysis of Variance of Arcsin Transformed Serial Position Scores

Source of Variation	df	MS	F
Between Cells	9		
Grade	4	.479	11.90*
Sex	1	.000	.00
Error (G x S)	4	.040	
Within Cells	130		
Length	1	.054	1.63
Position	6	1.040	31.13**
G x L	4	.045	1.36
G x P	24	.077	2.31*
L x S	1	.017	.52
L x P	6	.040	1.20
S x P	6	.026	.78
S x L x P	6	.010	.31
G x S x L	4	.016	.48
G x S x P	24	.029	.86
Error (G x S x L x P)	24	.033	
Total	139		

*$p < .05$
**$p < .001$

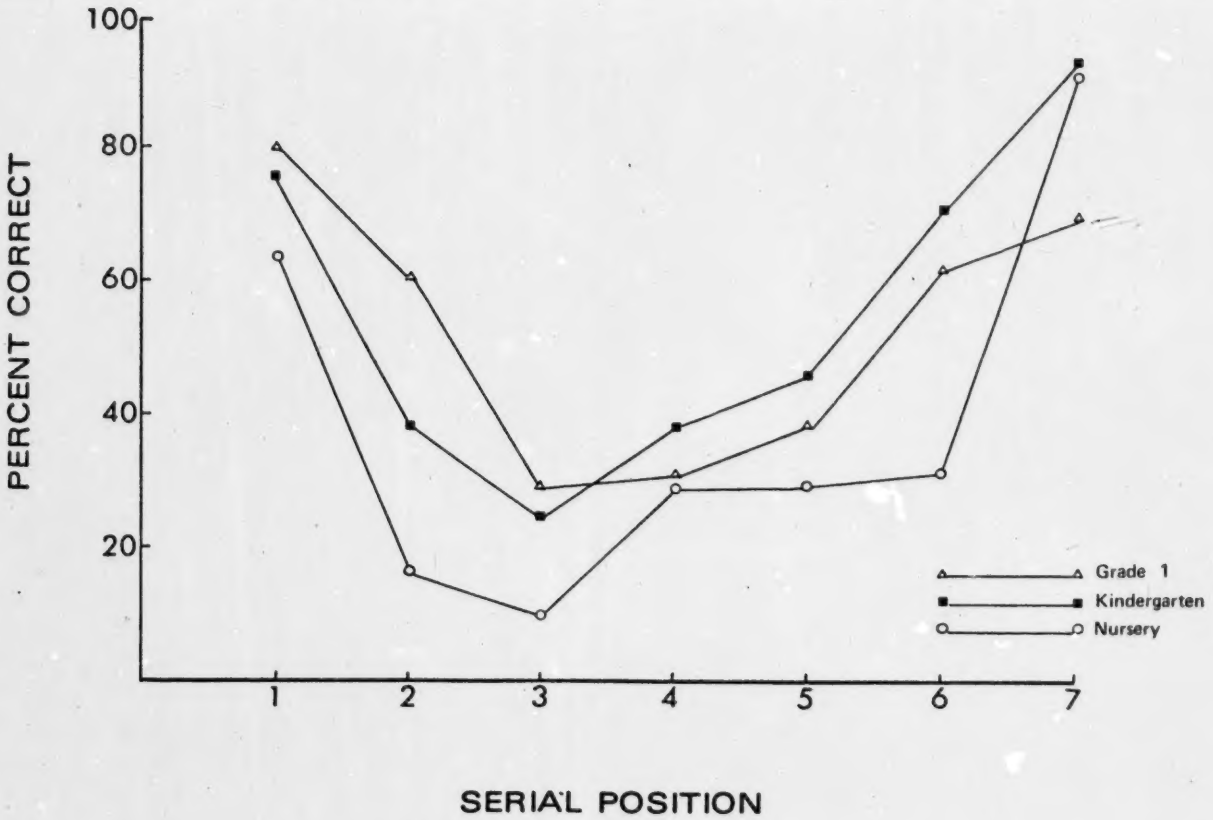

Figure 1. Percent correct responses summed over one- and two-syllable lists for Nursery, Kindergarten, and Grade 1.

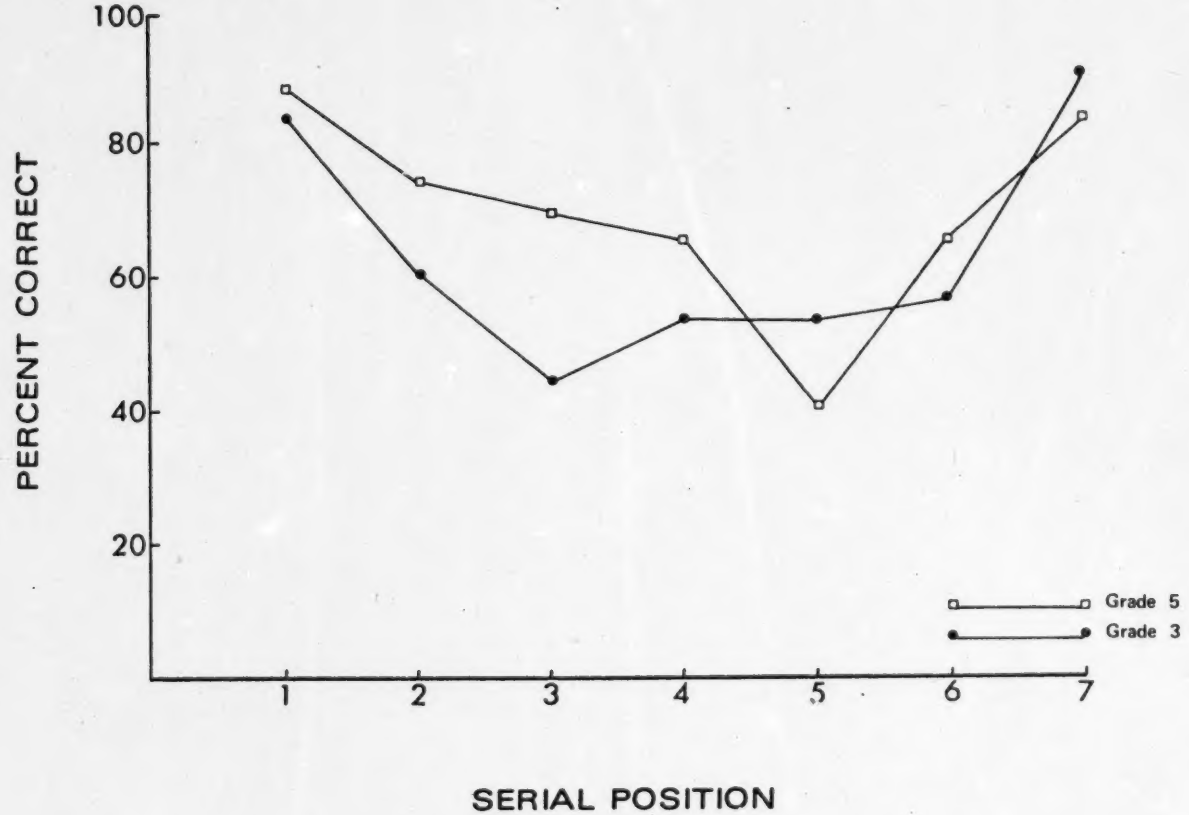

Figure 2. Percent correct responses summed over one- and two-syllable lists for Grades 3 and 5.

The Grade x Syllable Length x Serial Position interaction was not significant, $F < 1$. However, since the effect of Syllable Length was only significant at Grades 3 and 5, additional Syllable Length x Serial Position analyses were performed. A 3 (Grade) x 2 (Syllable Length) x 7 (Serial Position) analysis on the scores of nursery, kindergarten, and first-grade subjects indicated that the Grade x Syllable Length x Serial Position interaction was not significant, $F < 1$. Therefore, the scores for these grades were combined and are presented in Figure 3. The same serial position functions for Grades 3 and 5 are presented grapnically in Figures 4 and 5, respectively. To assess the effect of syllable length on performance at the primacy and recency portions of the serial position curve, the total number of correct responses at the first three serial positions (primacy) and the combined number of correct responses in the last three serial positions (recency) was tabulated for each subject. Then, three separate 2 (Syllable Length) x 2 (Position: Primacy versus Recency) analyses of variance were performed. The analysis for nursery, kindergarten, and Grade 1 combined yielded a nonsignificant Syllable Length x Position interaction, $F < 1$; the analysis of Grade 3 yielded a significant Syllable Length x Position interaction, $F(1, 27) = 5.29$, $p < .05$; and the analysis of Grade 5 yielded again a nonsignificant Syllable Length x Position interaction, $F < 1$. As can be seen in Figure 3, performance of the younger children was very similar in both syllable length conditions at both the primacy and recency portions of the curve; the significant effect of syllable length found at Grade 3 was due almost entirely to the superiority of one-syllable items at the primacy portion of the curve (i.e., the first three serial positions); and at Grade 5, performance on one-syllable items was superior at Positions 2, 3, 4, 5, and 7. In other words, the superiority of one-syllable items that was seen only at the primacy positions for Grade 3 extended across both primacy and recency portions of the curve at Grade 5.

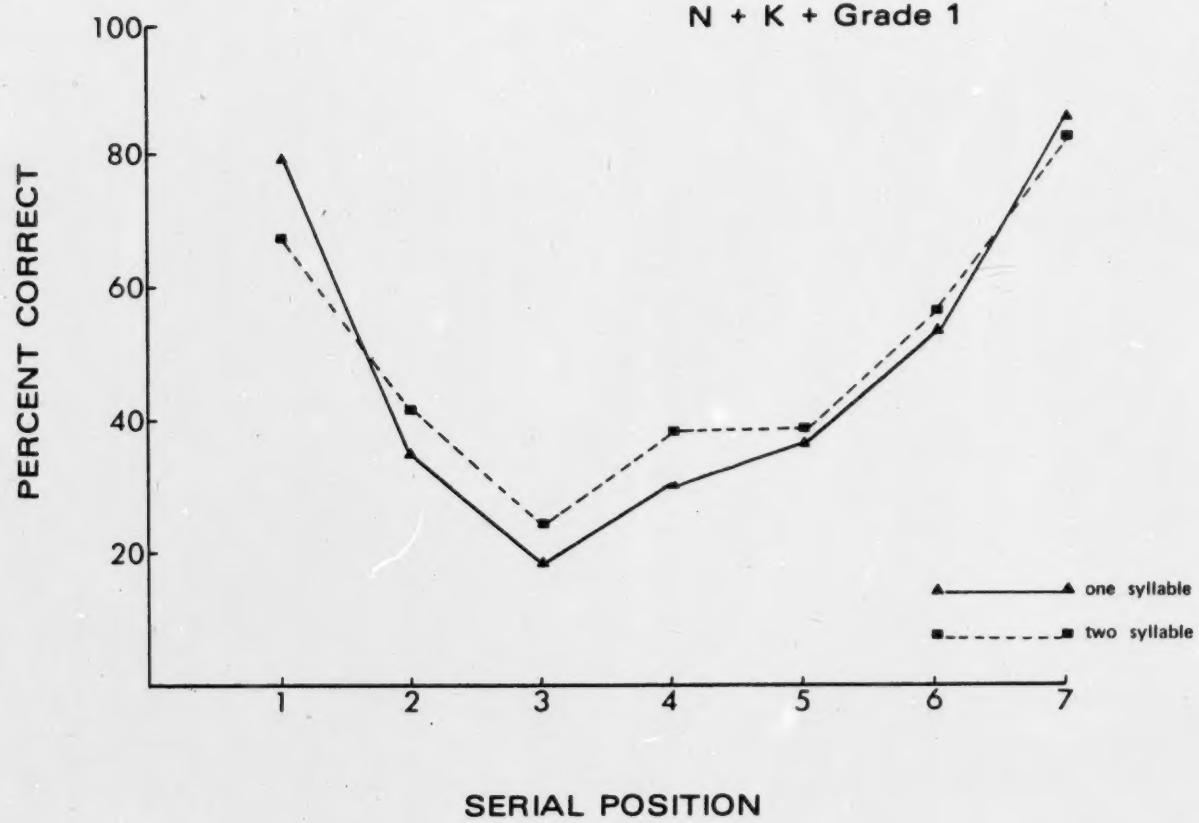

Figure 3. Percent correct responses on one- and two-syllable items for Nursery, Kindergarten, and Grade 1 combined.

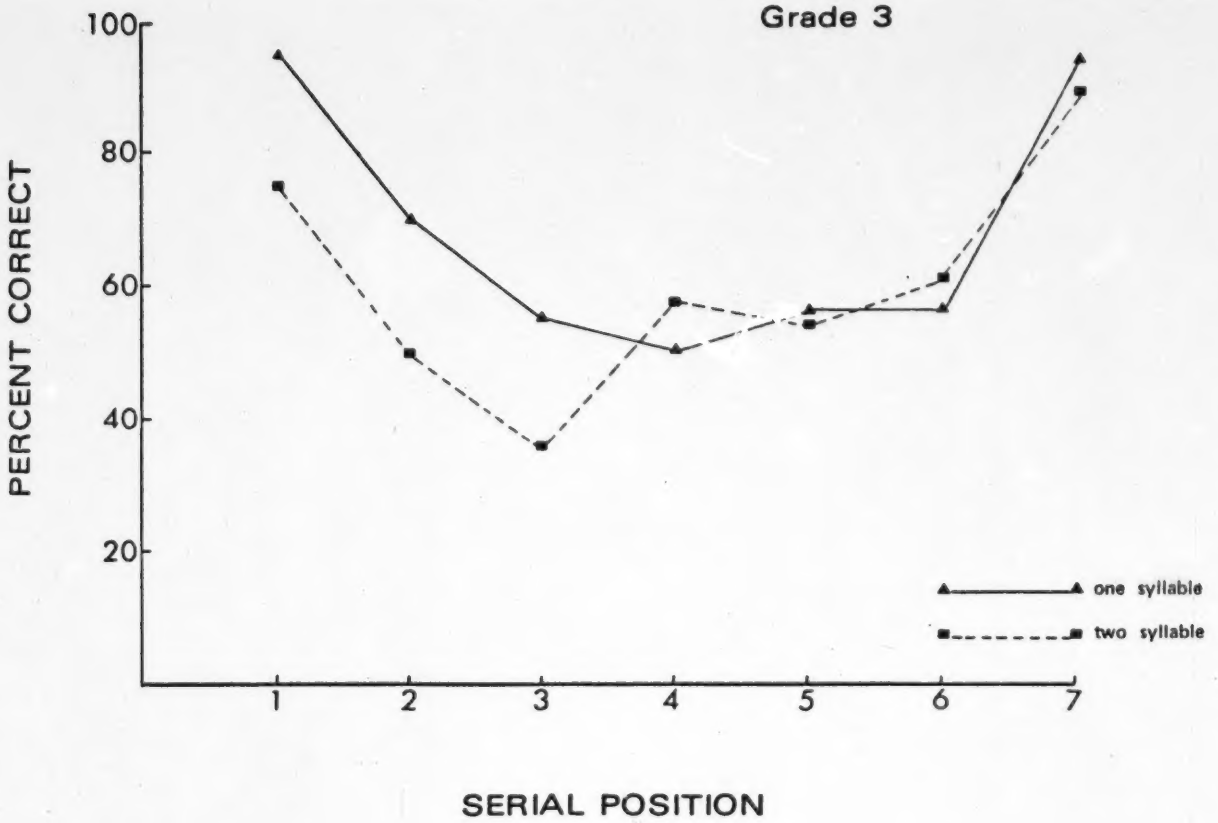

Figure 4. Percent correct responses on one- and two-syllable items: Grade 3.

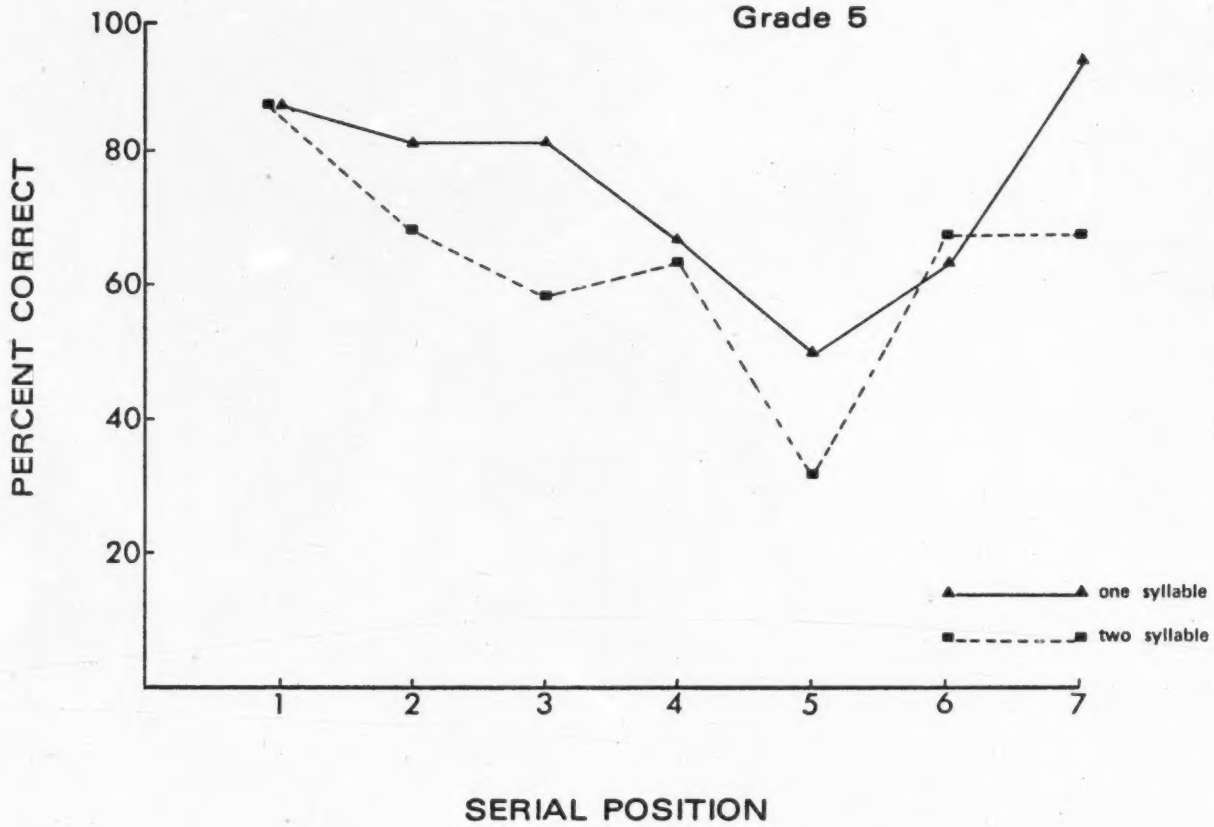

Figure 5. Percent correct responses on one- and two-syllable items: Grade 5.

Order

To examine the effects of the series order and probe order, a separate 5 (Grade) x 2 (Sex) x 2 (Series Order) x 2 (Syllable Length) x 7 (Probe Order) mixed factorial analysis of variance, with repeated measures on the last two factors, was performed on the number of correct responses in each syllable length condition for each subject. Neither the effect of series order, $F < 1$, nor probe order, $F(6, 24) = 1.06$, $p > .05$, nor their interaction, $F(6, 24) = 2.10$, $p > .05$, was significant.

Posttest Inquiry

On the basis of their reports of the memory strategies used, subjects were divided into two groups. One group included all subjects who convincingly described or demonstrated aloud a cumulative rehearsal strategy (CR). All other subjects were assigned to the other group, the nonrehearsers (NR). Nursery children were not able to give meaningful responses to the inquiry and were thus not included in this analysis.

The number of cumulative rehearsers (CR) and nonrehearsers (NR) at each grade level and their respective performance in each syllable length condition are presented in Table 4. The number of children reporting a cumulative rehearsal strategy increased from 3/28 at the kindergarten level to 23/28 at fifth grade. There were fewer rehearsers than nonrehearsers in kindergarten and first grade combined (14 CR versus 42 NR), while there were more rehearsers than nonrehearsers in Grades 3 and 5 combined (37 CR versus 19 NR), χ^2 (1 df) = 18.83, $p < .001$ (with Yate's correction). The difference in overall performance between rehearsers and nonrehearsers was not significant at any grade level, $t(13) \leq 1.07$, $p > .05$.

Table 4

Percent Correct Responses for Cumulative Rehearsers (CR) and Nonrehearsers (NR) in Kindergarten and Grades 1, 3, and 5

Syllable Length	Kindergarten		Grade 1		Grade 3		Grade 5	
	CR (3)	NR (25)	CR (11)	NR (17)	CR (14)	NR (14)	CR (23)	NR (5)
One Syllable	38	54	56	52	70	63	78	66
Two Syllable	53	57	52	55	62	58	63	74
Total	45	55	54	53	66	61	70	70

It should be noted that mean performance level (Table 1, page 12) masks striking differences in individual performance at each grade level. The percentage of correct responses of nursery schoolers ranged from 14-64, of kindergarteners from 29-71, first graders from 29-86, third graders from 36-86, and fifth graders from 50-93. Thus, the best performance in the youngest age group surpassed the poorest performance in the oldest group.

Discussion

As was expected, overall performance improved with age, with the most marked increase coming between nursery and kindergarten (4 1/2 years and 5 1/2 years). As predicted, the younger subjects (nursery, kindergarten, Grade 1) performed equally well in both syllable length conditions. Furthermore, there was no differential effect of syllable length on their performance at any portion of the serial position curve. These findings suggest that subjects at these grade levels engage in little effective cumulative rehearsal.

The older subjects (Grades 3 and 5) performed significantly better on one-syllable than on two-syllable items. At the third-grade level, superior performance on one-syllable items occurred at the primacy portion of the serial position curve, lending additional support to the interpretation that the differential performance between the two conditions can be attributed to cumulative rehearsal. The fact that performance on one-syllable items was generally elevated across most of the serial position curve for fifth-grade subjects can be attributed to the greater facility of these subjects with the cumulative rehearsal strategy. Because of their ability to rehearse a longer series of items than the third-grade subjects, their performance on the one-syllable series is consistently better than their performance on two-syllable items.

Primacy effects were found for nursery, kindergarten, first-grade, and third-grade subjects. The absence of a primacy effect is usually interpreted as evidence that rehearsal has not taken place (e.g., Bernbach, 1967; Hagen & Kail, 1973). Does the presence of a primacy effect on a serial position recall task necessarily indicate that the subjects are rehearsing, as is frequently implied (e.g., Bernbach, 1967; Ellis & Hope, 1968)? Underwood (1972) has stated, in reference to single-trial free recall, that: "The primacy effect seems to be due entirely to the fact that the initial serial positions provide a convenient and near universally used basis for serial rehearsal" (p. 12).

The rationale for interpreting a primacy effect as indicating rehearsal can be traced to the dual memory system proposed by Waugh and Norman (1965), as well as to the work of Glanzer and Cunitz (1966), Atkinson and Shiffrin (1968), and others. The essential argument is that rehearsal transfers items from STM to LTM, and the initial items in the series have received the greatest amount of rehearsal.

As has been pointed by Norman (1969), there are other possible explanations for the primacy effect. A proactive interference explanation would postulate that the earlier items in the list interfere with the later items: The primary memory phenomenon enables the subjects to recall the most recent items, but proactive interference depresses the recall of items from the middle of the list. This explanation could account for the discrepant findings that are often seen among studies that have used the Atkinson et al. (1964) task with subjects of the same age. Many studies that have used the task with younger subjects and have found only a minimal primacy effect have used the same stimuli over trials (Atkinson et al., 1964; Hagen & Kail, 1973; Hagen & Kingsley, 1968; Kingsley & Hagen, 1969), while studies similar to the present study, in which different stimuli have been used on each trial, have found a marked primacy effect (Keely, 1971; McCarver & Ellis, 1973; Siegel & Allik, 1973). The lack of a primacy effect with repeated stimuli could well be explained on the basis of inter-trial proactive interference caused by the use of the same stimuli over trials.

The Atkinson et al. task has a component that is not found in most serial learning paradigms: Each stimulus item has an idiosyncratic spatial location, and it remains in that location during the entire trial. Thus, each initial item has a distinctive feature in that it is the only stimulus except the final item that does not have another stimulus on either side. It may be that this distinctive feature of the initial item is contributing to the primacy effect. Support for this interpretation can be found in a recent study by Hintzman, Block, and Summers (1973) who found that the subjects were able to recall the general serial position of a word even when they were not able to place it in the correct list; i.e., they used contextual associations.

Primacy has also been accounted for on the basis of a more limited "search set" that surrounds the initial items and creates a higher probability

of correct recall (Shiffrin, 1970). Primacy effects have been found even when subjects were given 15-item lists and were required to repeat each word as it was presented six times during the three-second inter-item intervals (Glanzer & Meinzer, 1967). This requirement can be considered analogous to the strategy used by many younger subjects in which they repeat the name of each item several times as it is presented but do not rehearse the items cumulatively.

It seems appropriate to conclude that the primacy effect found for the younger subjects in the present study does not indicate that they were using a cumulative rehearsal strategy; and the absence of differential performance between the two syllable length conditions supports this contention.

However, the question remains: Does differential performance on the primacy portions of the serial position curves between overt-label and no-label conditions indicate rehearsal in young subjects (McCarver & Ellis, 1972)? An alternative explanation is proposed. Waugh and Norman (1965) point out that the effect of response interference is equal to that of stimulus interference. It is possible that requiring subjects in the label conditions to produce an overt response increases interference. This added interference could account for the decrease in primacy performance found by McCarver and Ellis (1972) in their label condition. Similar results with adults have also been attributed to interference of overt labeling with rehearsal (Hagen et al., 1970). While this may account for some of the primacy decrement in adults, other factors may contribute to this decrement as well. Furthermore, there is no justification for interpreting the serial position curves of adults and young children as reflecting the same underlying processes.

A review of the literature suggests that psychologists have frequently extrapolated findings from adult research and applied them to

work with children. Unfortunately, these investigators have frequently given little consideration either to different parameters of the tasks they have, of necessity, devised to be suitable for younger subjects, or to the developmental differences in the subjects themselves.

At no grade level was there a significant difference in overall performance between subjects who employed a cumulative rehearsal strategy and those who did not. This suggests that cumulative rehearsal may not be the only effective approach to the Atkinson et al. task. The wide range in performance noted at each grade level is additional support for this contention. Cumulative rehearsal was not being used by the younger subjects, and yet some of them were able to perform better than older subjects who were using the strategy. Jacoby and Bartz (1972) have suggested that rehearsal is not the only process that results in the transfer of items from STM to LTM and have argued that rehearsal might be viewed as having the single function of maintaining items in STM. Transfer of items to LTM would depend upon subsequent processing of the items. In their study, subjects learned lists of words for free recall and, in one condition, were told that they would have to engage in a rehearsal-preventing activity before recall. Although these subjects did not perform as well on the initial recall of each list as subjects who had either no delay or silent delay before recall, they did significantly better on a later request to recall the words from all of the lists. Jacoby and Bartz (1972) argued that the retrieval cues that had been generated by these subjects were more effective than the rehearsal process at retrieving items from LTM. Glanzer (1971) also points out that one function of STM is to allow time for whatever mnemonic work is to be done to insure that the item will be transferred to LTM. The rehearsal process may not, by itself, bring about the transfer of an item from STM to LTM (Glanzer, 1971; Jacoby, 1973).

McCarver and Ellis (1973) stated that their data seriously challenged Kingsley and Hagen's (1969) conclusion that five-year-old children do not rehearse spontaneously. The present data questions McCarver and Ellis's (1973) conclusion. Our results indicate that effective cumulative rehearsal does not begin until after first grade. Additionally, cumulative rehearsal may not be the optimal strategy for this task.

References

Appel, L. F., Cooper, R. G., McCarrell, N., Sims-Knight, J., Yussen, S. R., & Flavell, J. H. The development of the distinction between perceiving and memorizing. Child Development, 1972, 43, 1365-1381.

Atkinson, R. C., Hansen, D. N., & Bernbach, H. A. Short-term memory with young children. Psychonomic Science, 1964, 1, 255-256.

Atkinson, R. C., & Shiffrin, R. M. Human memory: A proposed system and its control processes. In K. E. Spence & J. T. Spence (Eds.), The psychology of learning and motivation (Vol. 2). New York: Academic Press, 1968.

Bartlett, F. C. Remembering. Cambridge, England: Cambridge University Press, 1932.

Belmont, J. M., & Butterfield, E. C. The relations of short-term memory to development and intelligence. In L. P. Lipsitt & H. W. Reese (Eds.), Advances in child development and behavior (Vol. 4). New York: Academic Press, 1969.

Belmont, J. M., & Butterfield, E. C. What the development of short-term memory is. Human Development, 1971, 14, 236-248.

Bernbach, H. A. The effect of labels on short-term memory for colors with nursery school children. Psychonomic Science, 1967, 7, 149-150.

Carroll, J. B., Davies, P., & Richman, B. The American heritage word frequency book. New York: Houghton Mifflin, 1971.

Colgate, R. L., & Eriksen, C. W. Implicit speech as an encoding mechanism in visual perception. American Journal of Psychology, 1970, 83, 208-215.

Conrad, R., & Hull, A. J. Input modality and the serial position curve in short-term memory. Psychonomic Science, 1968, 10, 135-136.

Corballis, M. C. Patterns of rehearsal in immediate memory. British Journal of Psychology, 1969, 60, 41-49.

Craik, F. I. M. The fate of primary memory items in free recall. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 143-148.

Crowder, R. G., & Morton, J. Precategorical acoustic storage (PAS). Perception and Psychophysics, 1969, 5, 365-373.

Ellis, N. R., & Hope, R. Memory processes and the serial position curve. Journal of Experimental Psychology, 1968, 77, 613-619.

Eriksen, C. W., Pollack, M. D., & Montague, W. E. Implicit speech: Mechanism in perceptual encoding. Journal of Experimental Psychology, 1970, 84, 502-507.

Flavell, J. H., Beach, D. R., & Chinsky, J. M. Spontaneous verbal rehearsal in a memory task as a function of age. Child Development, 1966, 37, 283-299.

Flavell, J. H., Friedrichs, A. F., & Hoyt, J. D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-340.

Glanzer, M. Storage mechanisms in recall. In G. H. Bower (Ed.), The psychology of learning and motivation (Vol. 5). New York: Academic Press, 1971.

Glanzer, M., & Cunitz, A. R. Two storage mechanisms in free recall. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 351-360.

Glanzer, M., & Meinzer, A. The effects of intralist activity on free recall. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 928-935.

Hagen, J. W., & Kail, R. V., Jr. Facilitation and distraction in short-term memory. Child Development, 1973, 44, 831-836.

Hagen, J. W., & Kingsley, P. R. Labeling effects in short-term memory. Child Development, 1968, 39, 113-121.

Hagen, J. W., Meacham, J. A., & Mesibov, G. Verbal labeling, rehearsal, and short-term memory. Cognitive Psychology, 1970, 1, 47-58.

Hays, W. L. Statistics. New York: Holt, Rinehart, & Winston, 1973.

Hintzman, D. L. Articulatory coding in short-term memory. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 312-316.

Hintzman, D. L., Block, R. A., & Summers, J. J. Contextual association and memory for serial position. Journal of Experimental Psychology, 1973, 97, 220-229.

Jacoby, L. J. Encoding processes, rehearsal, and recall requirements. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 302-310.

Jacoby, L. J., & Bartz, W. H. Rehearsal and transfer to LTM. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 561-565.

Keely, K. Age and task effects in short-term memory of children. Perception and Psychophysics, 1971, 9, 480-481.

Keeney, T. J., Cannizzo, S. R., & Flavell, J. H. Spontaneous and induced verbal rehearsal in a recall task. Child Development, 1967, 38, 953-966.

Kingsley, P. R., & Hagen, J. W. Induced versus spontaneous rehearsal in short-term memory in nursery school children. Developmental Psychology, 1969, 1, 40-46.

Landauer, T. K. Rate of implicit speech. Perceptual and Motor Skills, 1962, 15, 646.

Locke, J. L., & Fehr, F. S. Subvocal rehearsal as a form of speech. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 495-498. (a)

Locke, J. L., & Fehr, F. S. Young children's use of the speech code in a recall task. Journal of Experimental Child Psychology, 1970, 10, 367-373. (b)

Locke, J. L., & Fehr, F. S. Subvocalization of heard or seen words prior to spoken or written recall. American Journal of Psychology, 1972, 85, 63-68.

McCarver, R. B., & Ellis, N. R. Effect of overt verbal labeling on short-term memory in culturally deprived and non-deprived children. Developmental Psychology, 1972, 6, 38-41.

McGuigan, F. J. Covert oral behavior during the silent performance of language tasks. Psychological Bulletin, 1970, 74, 309-326.

Norman, D. Memory and attention. New York: Wiley, 1969.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971.

Paivio, A., & Csapo, K. Concrete image and verbal memory codes. Journal of Experimental Psychology, 1969, 80, 279-285.

Reitman, J. S. Mechanisms of forgetting in short-term memory. Cognitive Psychology, 1971, 2, 185-195.

Rohwer, W. D., Jr. Elaboration and learning in childhood and adolescence. In H. W. Reese (Eds.), Advances in child development and behavior. New York: Academic Press, 1973.

Rundus, D. Analysis of rehearsal processes in free recall. Journal of Experimental Psychology, 1971, 89, 63-77.

Rundus, D., & Atkinson, R. C. Rehearsal processes in free recall: A procedure for direct observation. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 99-105.

Shaffer, W. O., & Shiffrin, R. M. Rehearsal and storage of visual information. Journal of Experimental Psychology, 1972, 92, 292-296.

Shiffrin, R. M. Memory search. In D. A. Norman (Ed.), Models of human memory. New York: Academic Press, 1970.

Siegel, A. W., & Allik, J. P. A developmental study of visual and auditory short-term memory. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 409-418.

Underwood, B. J. Are we overloading memory? In A. W. Melton & E. Martin (Eds.), Coding processes in human memory. New York: V. H. Winston & Sons, 1972.

Waugh, N. C., & Norman, D. A. Primary memory. Psychological Review, 1965, 72, 89-104.